

**INTEGRATED SURFACE-MACHINED MICRO FLOW CONTROLLER  
METHOD AND APPARATUS**

**ABSTRACT OF THE DISCLOSURE**

A surface-micromachined mass flow controller (MFC) comprises an electrostatically actuated microvalve integrated with a thermal flow sensor. The microvalve comprises a normally-open diaphragm defining an aperture allowing fluid communication between first and second flow channels. The diaphragm includes a second electrode actuatable toward a valve seat including a first electrode. Fabricated utilizing a multilayer Parylene process, the active microvalve and the flow sensor are integrated onto a single chip to perform closed-loop flow control. For flow control, both Pulse Width Modulation (PWM) and actuation voltage adjustment are demonstrated.

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